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The ethics of invention



Paul Fanning, Editor (pfanning@findlay.co.uk)

Innovation is the watchword of engineering in general and this magazine in particular. We applaud whenever new technological ground is broken and the cause of progress is advanced. And yet there is a long list of technologies that have been beneficial to mankind, but have also brought drawbacks.

Obvious examples are easy to bring to mind. For instance, the modern transportation systems that enable us to shrink the world, but at the same time pollute the planet or result in accidents.

Of course nobody in their right mind would look at these downsides and wish the car, plane or train uninvented. However, as technology becomes ever more sophisticated, its presence in the most personal aspects of our lives has raised ever more tricky questions.

A particularly interesting example of this arose in conversation with the man on this month's cover, Professor Hugh Herr. When he was discussing his hope to create bionic technologies that could overcome psychological as well as physical impairment, the question of ethics was inevitably raised. Not only were the uses to which such an invention could potentially be put worrying, but so were the ramifications of permanently altering personality and behaviour.

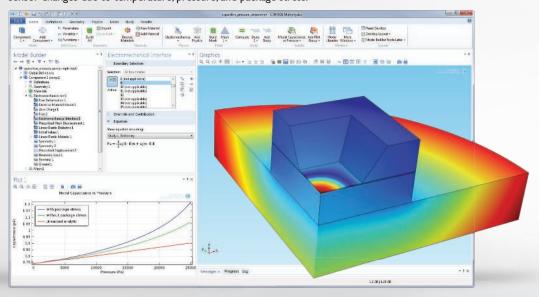
Professor Herr responded reasonably that such an approach was surely preferable to the current treatment of disorders with imprecise chemicals with side effects and that ethical issues would have to be a question for lawmakers rather than engineers and scientists. However, the question of what responsibility the inventor holds for their invention's application lingers.

Ultimately, of course, such a question is unfair. We cannot reasonably ask engineers to curb their inventiveness because of some imponderable use to which their invention may or may not be put. However, what is interesting about these questions (and, more pertinently, the frequency with which they arise) is that they suggest a growing nervousness about technological progress and the increasingly intimate role it plays in our lives.

It is right, of course, to be cognisant of the potential dangers posed by technology, but at the same time it is crucial that we do not allow these dangers to obscure the usually much greater benefits.

After all, there is no such thing as a bad technology, only a bad application.

PRESSURE SENSOR: Model showing how the capacitance of a MEMS sensor changes due to temperature, pressure, and package stress.



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BAE brings Iron Man tech to the battlefield



The new Q-Warrior head-up display from BAE Systems has been specifically designed to keep soldiers out of harm's way.

Currently undergoing field testing by the US military, the system is designed to provide foot soldiers with a full-colour, high-resolution 3D

display of the battlefield situation and assets.

Q-Warrior actually features two displays: a high transmission, highluminance see-through display and a high resolution, full-colour, collimated display that allows the use of symbols and video.

BAE says the system increases the user's situational awareness by providing the potential to display 'eyes-out' information to the user, including textual information, warnings and threats.

Other key features include enhanced night vision, waypoints and routing information, and the ability to track both personnel and assets.

According to BAE, the Q-Warrior will initially be employed at the section commander level, but will eventually become standard frontline kit.

"The biggest demand, in the short term at least, will be in roles where the early adoption of situational awareness technology offers a defined advantage," said Paul Wright, business development lead for BAE's Electronic Systems unit.

"The next level of adoption could be light role troops such as airborne forces or marines, where technical systems and aggression help to overcome their lighter equipment."

Engineering apprenticeships twice as popular as degrees

The number of young people embarking on an engineering apprenticeship is more than double that of those choosing to study for a degree. Figures from the Skills Funding Agency show that in 66,410 young people started an apprenticeship in engineering and manufacturing technologies in 2013, more than double the 27,155 accepted onto engineering higher education courses.

IET membership director Michelle Richmond said: "With a university degree costing £27,000 in fees alone and with no guarantee of a job at the end of the course, apprenticeships are more popular than ever with young people.

"And with the recent Government Trailblazer initiative, led by the IET and other industry leaders to introduce new standards to make sure apprenticeships meet employer needs, we can only expect apprenticeships to go from strength to strength."

Rolls-Royce announces future engine designs

Looking to build on the success of its Trent XWB family, Rolls-Royce has announced two new engine designs aimed at next generation civilian aircraft.

The British group said that Advance, the development name for one of its future engines, will burn at least 20% less fuel – with a corresponding drop in CO2 emissions – compared with the first generation of Trent engines that entered service in 1995.

The second engine, UltraFan – a geared design with a variable pitch fan system – will offer a 25% improvement in fuel burn and emission, Rolls said.

Advance is expected to enter service by 2020, with UltraFan slated for a 2025 launch.

Colin Smith, Rolls-Royce director of engineering and technology, commented: "These new designs are the result of implementing our ongoing technology programmes.

They are designed to deliver what our airframe and airline

customers tell us they need: even better fuel efficiency, reliability and environmental

performance."

Both engines will include a new engine core architecture and a CTi Fan System made up of carbon/titanium fan blades and a composite casing.

According to Rolls, this fan system will reduce weight by up to 1,500lb per aircraft, the equivalent of

carrying seven more passengers.

As well as a new geared design, Advance and UltraFan will also make use of advanced ceramic matrix composites – heat resistant components that operate more effectively in high turbine temperatures.

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Automation for the future

The name ifm electronic stands for a wide range of different sensors and systems for automation technology. For forty years the company has been researching, developing and producing with the aim of optimising technical processes and conserving resources.

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NEWS



Aerogel offers 'greener' way to clean up oil spills

A new type of aerogel technology is being developed in the US, which could offer a cheaper and 'greener' way to absorb oil and heavy metals from water.

Created by a team from the University of Wisconsin–Madison, the patent-pending aerogel is made up of cellulose nanofibrils (sustainable wood-based materials) and an environmentally friendly polymer. "For this material, one unique property is that it has superior absorbing ability for organic solvents – up to nearly 100x its own weight," said researcher Shaoqin Gong. "It also has strong absorbing ability for metal ions."

o give the aerogel its water-repelling and oil-absorbing properties, the researchers freezedried it and then treated it with specific types of silane.. In compression mechanical testing, the aerogel was said to exhibit excellent flexibility. Though much work needs to be done before it can be mass-produced, Gong says she's eager to share the technology's potential benefits.

Samsung files suit over Dyson claims

Samsung Electronics has filed a lawsuit demanding 10bn Korean won (£5.6m) in compensation from the British appliance maker Dyson because it claims it was depicted as a copycat.

The lawsuit, filed in the Seoul district court in Korea, were filed against Dyson because its "previous litigation has hurt Samsung's corporate image", the company told the Korea Times.

The move follows the decision by Dyson in October 2013 to drop a patent infringement case that it

brought against Samsung in August, in which it claimed that the Korean giant had copied the steering system used in its Motion Sync cleaner from the Dyson DC37 and DC39 cleaners.

Samsung was able to defend itself against Dyson's case by presenting 'prior art' (an example of the idea being used before Dyson had patented it).

Dyson said in a statement: "Dyson pioneered cyclonic vacuum cleaners and digital motors – and has been developing them ever since. We patent our technology, and naturally defend it. It is surprising that a company over 100 times bigger than Dyson is so worried. The patent system offers us some protection but not enough: with an army of lawyers, hidden prior art is occasionally found and ways to design around existing patents identified."

UK manufacturing output continues to grow

Manufacturing order books remained robust and output growth accelerated in February, according to the CBI.

A survey of 380 manufacturers found that total order books improved slightly on January, although they remained below levels recorded in November and December.

Overall export orders also rebounded after a drop in January. The motor vehicles sector was the biggest contributor to the improvement in export orders, recording its strongest performance since October 2011.

Output grew at one of the strongest rates since survey records began in 1975. Optimism about output prospects also improved, with expectations for output growth over the coming three months at their strongest since September - 16 out of 17 sectors expect output to expand over the next three months.

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QE Prize chairman makes plea for female engineers



As nominations open for £1m Queen Elizabeth Prize for Engineering there has been a call for the parents of girls to look at engineering differently.

As the judging panel for the QEPrize was unveiled and the call made for nominations from across the world, the Queen Elizabeth Prize for

Engineering Foundation chairman, Lord Browne of Madingley, called on parents to take a fresh look at engineering, and to encourage both their sons and daughters to consider it as an exciting and rewarding profession.

Says Lord Browne: "From large-scale infrastructure to medical technology, engineers' achievements transform every aspect of our daily lives. Our research shows that parents are reluctant for their daughters to enter the field of engineering, believing that other subjects offer them better opportunities.

The Queen Elizabeth Prize aims to make heroes and heroines out of the engineers who are behind the world's greatest innovations, demonstrating that engineering can offer a rich and rewarding career to both men and women"

The Queen Elizabeth Prize for Engineering is a £1 million global award which celebrates the engineers responsible for a ground-breaking innovation in engineering that has been of global benefit to humanity. The judging panel comprises some of the biggest names in engineering and science from around the world,

http://qeprize.org/





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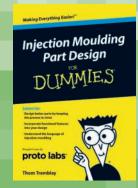




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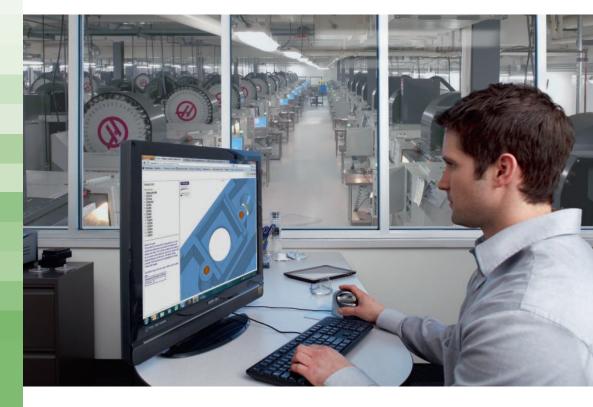
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Entries open for 2014 British Engineering Excellence Awards

Entries are now being accepted for the 2014 British Engineering Excellence Awards.

Now in their sixth year, the Awards are designed to celebrate those UK companies and individuals that have demonstrated the skills, invention and dedication not only to compete, but to succeed on an international stage.

Categories for the Awards run the gamut of engineering design and include:

- · Consultancy of the Year
- Design Engineer of the Year
- Design Team of the Year
- · Green Product of the Year
- Materials Application of the Year
- New Product of the Year (Electronic)
- New Product of the Year (Mechanical)

- Small Company of the Year
- Start Up of the Year
- Young Design Engineer of the Year

In order to ensure that companies of all sizes are able to compete on a fair and even basis, the Judges will take into consideration such factors as team size, project budget, project design cycle time, the regulatory environment, the competitive nature of the target market, the materials and technology selected by the design team and the attention to environmental issues.

Entries for the British Engineering Excellence Awards close on 30 June 2014. The entries will be judged by an expert panel chaired by Eric Wilkinson, Chief Operating Officer of Cambridge Consultants.



british engineering excellence awards

The Awards will be presented at a lunch event, being held at 8 Northumberland Avenue, London on 9 October.

If you believe you have what it takes to win in any of these categories – or know of a product, company or individual that does – entry forms, detailed entry criteria and any additional information you may require about the Awards categories can be found at www.beeas.co.uk.



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Turbine Blades manufactured from flax

Composites Evolution's Biotex Flax has been used to manufacture natural fibre reinforced blades for a rooftop wind turbine at the University of Stuttgart.

The blades were conceived, designed and manufactured by the SWE (Endowed Chair of Wind Energy) at the University, the team having found that Biotex Flax reinforcement's unique twistless technology gave them the performance characteristics that they were looking for.

SWE's research is focused on improving the reliability of

turbines whilst reducing the production costs of wind energy. It started design in 2011, with the aim of constructing new rotor blades for the university's 1kW rooftop wind turbine. After a trip to The Eden Project in the UK, the team wanted to familiarise themselves with natural fibres and contacted Composites Evolution to test the performance of its Biotex materials.

Along with a range of other materials, the fibres were tested with different resins to validate their performance

characteristics. SWE found that Composites Evolution's Biotex Flax correlated best with the



performance they expected and it felt they had a good data basis to make a lightweight and stiff natural fibre blade.

The blade, consisting of Biotex Flax 2x2 twill 400gsm as the main shell and Biotex Flax unidirectional 275gsm used for the blade's belt and root, was built in two halves. Both were hand-laminated and then vacuum-bagged in two female moulds. The two separate halves were then joined using Momentive's RIM 235 epoxy resin.

www.compositesevolution.com

Solution to last month's Coffee Time Challenge

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The solution to last month's Coffee Time Challenge to come up with a way for a motorcyclist to access and view various telemetry information such as speed and fuel levels as well as multimedia systems such as a satnav and hands-free kit, comes from smart helmet manufacturer Skully. At the heart of its helmet is a Head Up Display (HUD) that projects continuous information within the riders field of vision.

The system called the Synapse Integrated Heads-Up Display provides riders with advanced situational awareness by showing navigation and blind spot data to allow riders to focus the road. It also features a 180° rear view camera to literally give riders eyes in the back of their heads. It allows riders to see behind and also to both sides to cover blind spots, critically

allowing eyes to be kept forward without having to physically turn the head.

Skully says its helmet provides riders with an unprecedented level of situational awareness. It calls on research that suggests that a Heads-Up Display on a motorcycle, when properly implemented, can vastly improve the safety and situational awareness.



As well as integrating a satnav and working completely from voice commands, it enables Bluetooth pairing with smartphones for further voice activate functionality including accessing music, making calls, and changing a destination.

The company even go so far to describe the technology as 'augmented reality' but insist it does not distract the rider, but



better enables them to concentrate on the road. The display is positioned outside the rider's primary field of view, and appears approximately 6m away, the average focusing point for most while driving. The display aims to simplify the riding experience as riders do not have to avert their eyes from the road to see what is behind or look out for sign posts to navigate.

The battery lasts for 9 hours on continuous use. Recharging the battery is easy and can be done using any standard micro-USB cable. Riders can also tweak their own individual displays to suit both requirements and personnel preference. Despite only being in Beta testing, the helmet has already proved popular with the motorcycling community.

www.skullyhelmets.com

www.eurekamagazine.co.uk March 2014 15



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Position sensors for pneumatic & hydraulic cylinders



Sick UK is launching the MPS and MPA, two new magnetic analogue output position sensors for pneumatic and hydraulic cylinders that promise unprecedented levels of accuracy and control, combined with the versatility to be used universally for machine and robotics applications.

The key to the sensors' high-performance is a continuous analogue output signal for precision non-contact detection at all stroke positions with minimal blind zones. Simple to commission thanks to the sensors' intelligent teach-in function, they are designed for easy and quick mounting on T-slot housings with a range of bracket options for standard cylinder types.

"The new MPS and MPA cylinder sensors deliver unrivalled levels of control for universal automation tasks at an affordable price point," says Phil Dyas, SICK (UK) sensor specialist. "Machine builders and operators will come to rely on their high performance and reliability and will like their quick commissioning and fast replacement times."

The rugged MPA and the compact MPS support the widest range of high-precision positioning, measurement and detection applications such as spot welding, drilling, screwing and polishing. They feature both a4 to 24mA and 0 and 10v for exceptional positioning performance.

With 25 sizes from 107mm to 1007mm, the Sick MPA analogue magnetic sensor is ideal for longer stroke cylinder applications. Its precision operation achieves a linearity of 0.5mm at 1.15m/s. www.sick.co.uk

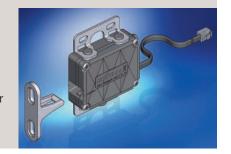
Vehicle and infrastructure control locking system

EMKA's approach to locking of specialist vehicle and infrastructure control cabinets covers both equipment access panels and personnel/passenger access doors. These systems are likely to be of value to engineers involved in manufacture of road and rail transport vehicles and the associated infrastructure control cabinets.

The EMKA vehicle system features both Bowden cable and electronic actuation possibilities, linked to a remote locking handle or radio key. This may be coupled to a single point or rotary latch lock

and appropriate door handle mechanism. Mechanically, this is controlled by multiple Bowden cables; electronically by radioactuators using either 12v or 24v.

www.emka.co.uk



High-performance rubbers for Subsea

Precision rubber moulding specialist, Metflex announces a new range of high performance rubbers designed specifically for demanding subsea applications. Called Metflex Subsea NRX, the API 17 compliant, natural rubber materials are available as moulded shapes for pipeline pigging connectors, protective shielding for HPHT pipelines, and riser and umbilical connection systems.



Natural rubber has many advantages over other materials subsea - very high tensile strength, resilience and ability to absorb dynamic stresses, and abrasion resistance.

The NRX rubbers offer temperature resistance in the range -50 to +80 degrees centigrade, 67-73 Shore hardness and compression set up to 14%. In large rubber blocks where greater stiffness is needed, Metflex is able to supply mouldings containing single and multiple metal inserts. www.metflex.co.uk.



Tata Steel Rail France has recently retrofitted its rail end straightness inspection systems with Keyence's latest generation of CCD laser displacement sensors, the LK Series.

During rail inspection, a carriage moves along the end of a rail at a rate of 3m/sec and over a distance of 3.2 m. The carriage is equipped with two LK-G triangulation sensors. The sensors generate a 2D profile of the rail surface at a rate of 10,000 sample points per second. If the rail is not straight, it is transferred to a press to be straightened to within the desired tolerance. Measurements are extremely fast and the measurement accuracy achieved is in the order of a few hundredths of a millimetre.

Tata Steel needed a laser sensor that could meet a number of high requirements: be able to adjust itself to shiny rail surfaces, take measurements very quickly to keep up with fast production rates and withstand harsh operating conditions.

To ensure repeatability of the measurements, Keyence developed a number of algorithms to guarantee measurement stability. The ABLE function detects the condition of the surface being scanned to maintain the laser light intensity at the optimum level.

www.keyence.co.uk

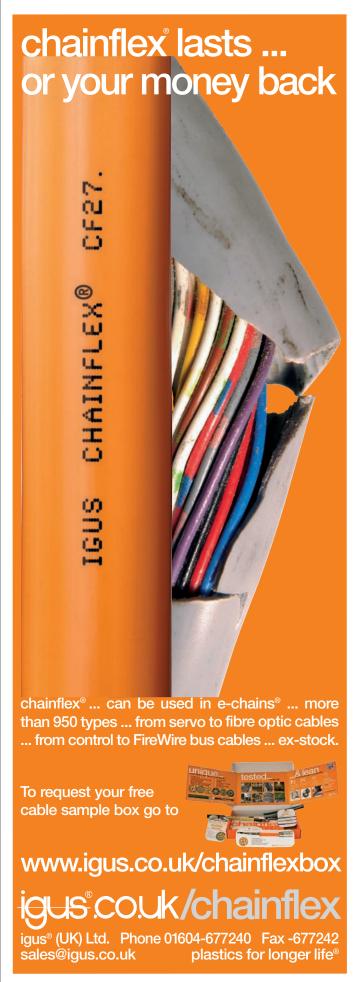




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Electric linear actuators offer breakthrough performance

Thomson Industries has introduced the new PC Series, a new generation of precision, electric linear actuators for continuous duty applications. They offer the highest power density of any actuator in its class. The compact, efficient design enables machine builders clear advantages over traditional pneumatic linear actuators including simpler machine designs, lower maintenance, higher overall

performance and substantially lower energy costs.

Traditional pneumatic actuator systems operate continuously, typically at 10-15% efficiency and also carry the high maintenance costs of compressors and air leaks. High efficiency ball screws employed in the new Thomson PC Series electric linear actuators have efficiencies of over 80% and use energy only on demand. Converting from pneumatic to electric actuation, for many applications, can generate in one year energy savings per axis which exceed the cost of the new actuator.

Thomson's PC Series electric linear actuators offer new flexibility to machine designers who frequently need to change set-ups to run different products or processes. Changing end stops or velocity profiles can be done on the fly with electric actuators, maximizing productivity and reducing scrap. The PC Series is similarly well-suited for food processing and packaging, material handling and factory automation applications where high accuracy and reliability and 100% duty cycle operation is required.

This generation of electric linear actuators from offers a lot of power in a small package size which allows machine designers to reduce their machine footprint. PC Series actuators in sizes 25, 32 and 40 have square sizes of only 34 mm, 45 mm and 55 mm, respectively; yet deliver as high as 6,000 N of thrust force. Stroke lengths of up to 1200 mm are available, twice as long as most competitive electric actuators in comparable frame sizes. The Thomson PC Series also conforms to ISO 15552 for mechanical interfaces and adapters, making machine upgrades quick and easy. www.thomsonlinear.com





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Bio-prosthetics are advancing far beyond simply offering poor substitutes for lost limbs towards genuinely enhancing the user's physical and cognitive capabilities. Paul Fanning reports.

ugh Herr claims semi-seriously to be "in the transportation business". There is a fairly significant twist, however, because, as he puts it: "I'm in the transportation business, but instead of big metal boxes with four wheels, I build body parts."

The body parts in question are bionic prosthetic limbs and Herr has an interest in them that extends far beyond the merely professional.

Why this should be is hinted at when Herr is asked what people need to become pre-eminent in their field in the way that he is. "Find a passion" is his answer and brief acquaintance with his biography quickly

acquaints one with the source of his.

In 1982, when he was 17, Herr and a friend were climbing Mount Washington when the weather closed in and they were caught in a blizzard. After spending three nights in -29°C temperatures, both had suffered severe frostbite. For Herr this meant the amputation of both of his legs below the knee.

Where this story becomes truly remarkable, however, is that following

months of surgery and rehabilitation, Herr was doing what doctors told him was unthinkable: climbing again using specialised prostheses of his own design. He used these to alter his height, avoid awkward body positions and grab hand and foot holds previously out of reach. Using these prostheses, his height was able to range from five to eight feet. As a result of using the prostheses, Herr went on to climb at a more advanced level than he had before the accident.

Today, Herr is an associate professor in MIT's Program in Media Arts and Sciences and in the Harvard-MIT Division of Health Sciences and Technology and head of the Biomechatronics research group at the MIT Media Lab. He is also the chief technology officer of Biom, a company specialising in bionic prosthetic limbs.

The key to this transformation, he feels, was the attitude he took to his situation after the loss of his legs. He says: "When my legs were amputated as a young man, I realised that – from the legs down – it was a blank palette. I could do whatever I wanted."

His positive attitude to his predicament has held Herr in excellent stead. He even describes himself as "lucky" to have lost both legs as "It's nice to be symmetrical and I have the added advantage that I can be as tall as I like". In fact, he sees this technology as utterly transformative, drawing a parallel between his prosthetics and the use of glasses in the way in which they effectively remove what was considered a disability and render the user a fully able, fully-functioning member of society. In

disability"

this context, he says: "You cannot with a straight face label me as disabled, because with this great technology, I climb mountains, for God's sake!"

This most shocking thing, he felt, was discovering how primitive prosthetic technology was following his amputations. "Our current technology degrades us as humans rather than enhancing us," he says. "I was fitted with conventional technology in 1982. The foot/ankle was locked and the foot was made of foam and wood – fundamentally not distinct from prostheses that existed a hundred years before. And I was like 'Is this it?' In the age of computers and automobiles and spacecraft? That's when I really dedicated myself to designing something more successful... I didn't view my body as broken, I viewed the technology as broken. There is no such thing as a disabled person, there are only disabled technologies - there is only poor design."

The Biom ankle/foot prostheses Herr uses, by contrast, are 'intelligent' and responsive devices. Each contains three microprocessors and 12 sensors, which detect various forces, positions, speeds and accelerations. They deploy an Achilles-like tendon spring and

"YOU CANNOT WITH A STRAIGHT FACE LABEL ME AS DISABLED, BECAUSE spring under computer control WITH THIS GREAT TECHNOLOGY, I CLIMB MOUNTAINS, FOR GOD'S SAKE!"

a muscle-like motor system that catapults the person forward as they walk or run.

At the heel strike, a torsion responds. The stiffness of the spring depends entirely on the force of the impact. From this, the device employs torque control to lift the patient upwards and forwards into the swing step. These factors allow

the Biom to adapt to speed and terrain automatically.

Says Herr: "The control system models the missing muscles, tendons and reflexes. And then we take sensory information from the bioprosthesis and input that into bio physical model, which then tells the computers on board what the torque and impedences of the bionic limbs should be. So the bionic limb moves as if it's made of muscles and tendons and spinal reflexes. It moves as if it's made of flesh and bone.

According to Herr, however, the distinguishing feature of this prosthetic limb is that it is the first ever prosthetic limb not to be humanpowered. "This applies tremendous mechanical energy into the human and augments their ability," he says.

"All other prostheses are essentially human-powered in the same way that a bicycle is human-powered and rely on residual muscle power to work. This device uses battery power. For the first time in history, this bionic limb normalises how fast a person can walk and how much energy they use to do so. It also greatly enhances stability: even on rough terrain, a person with both legs amputated can run up a hill."

Speaking of his own prostheses, Herr is effusive, saying: "When I walk, there's an exchange of information, an exchange of energy and an exchange of force between my biological self and my artificial self. It senses my biological postures and reflects its postures. It stores energy and catapults my biological self forward. My biological leg pushes on it, and it pushes back in a collaborative, seamless dance between flesh and machine."

All of these advances derive, claims Herr, from a concentrated effort to understand the human body better and to emulate it. He says: "Building a bionic limb that has the profound versatility of the human limb is incredibly hard. Right now when you open up your closet, you see lots of shoes. When I open up my closet, I see lots of legs. I have a leg for



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Photo: Adrien Bisson Photography





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running, I have a leg for climbing – I have about eight pairs. It's a challenge to build all that capability into a single limb. The human leg is so adaptable and versatile.

"We've managed to capture the basics of the human ankle for level walking and running. But if you've got someone who wants to go hiking or dancing, for example – ie non-repetitive actions – then we have real problems."

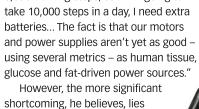
The concentration on effective emulation of human limbs takes place at Herr's lab at MIT, where huge amounts of time and resource are spent on mapping, analysing and understanding human physiology. The fact that Herr is a user of these devices as well as their inventor and designer does, of course, give him a unique insight into their design, but in the case of his collaborators who have all their limbs, this has to be simulated.

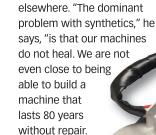
"I'm very fortunate in that I'm a designer and I know physics and engineering," says Herr, "but also that I feel it physically. That generally means I'm the first one to know if there's a bug and also to know which line of code has to change. To be able to a feel it is a very powerful tool. Of course, the people in my lab have normal limbs, so for them we have all sorts of contraptions like struts that allow them to wear the limbs, too, so that they can feel it. It's a lot of fun."

Herr is very clear, however, that there remains a huge amount still to be achieved in this field, saying: "A dominant hurdle is our lack of understanding of how the human body works. It's essentially a better understanding of how the body works that led to what I'm wearing today... I just start running and it responds. There's no neural connection."

long way to go yet. Just how far is hinted at when he says: "In this age of bionics, our limbs will no longer be separate lifeless mechanisms, but intimate extensions of our organic body," he says.

In fact, by outlining the current shortcomings of bionic technology, Herr points the way in terms of how he sees its development. The first problem he identifies are the power supplies, saying: "The battery on my limbs will go for about 3,000 walking steps, so if I'm going to





And yet a lot



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not even close to being able to build a machine that lasts 80 years without repair. And yet a lot of us humans go 80 years without repair because the biological body is constantly monitoring and repairing."

By way of contrast, he argues: "\$50m has been invested in this technology and the best we've been able to do is to last five years."

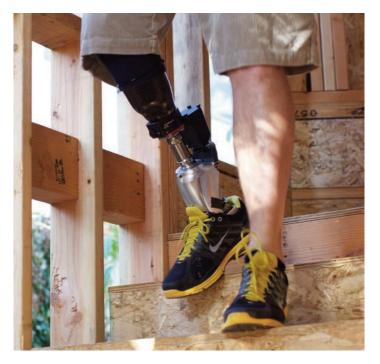
So what's coming next? The answer would appear to be neural connections that allow conscious control of and feedback from the limb. "The technology I'm wearing right now is very crude compared to where we'll be in a decade or two," says Herr. "There's an artificial intelligence in my current limbs, but there's no direct communication. But within ten years, limbs such as this will certainly be neutrally controlled. What will come first? The ability to think, send out the sensory command and then have that motor signal sent wirelessly to the limb.

"What will come after? The limb in action will stimulate the nervous system to give the person real perception of the synthetic limb. That's critical for balance, for instance. That feedback closes the loop between the human and the machine."

But Herr by no means sees bionics being limited to the limbs and other extremities. He finds the possibilities of bionic 'skin' particularly exciting..

"The future," he says, "is that the retail outlet will have robots that will scan the foot and fit the shoe exactly to your body part. He says: "How can we interface virtually any structure to the human body? Bras? Shoes? We have no idea what we're doing. The shoe is one of the oldest devices in human culture and we still get blisters! My God! We have no idea what we're doing."

"The future," he says, "is that the retail outlet will have robots that will scan the foot and fit the shoe exactly to your body part. You won't get blisters. And that synthetic skin will be rich with sensors and electronics that will extract all sorts of physical data and respond accordingly – so relax and stiffen joints, for instance. It's coming. We





ain't seen nothing yet!"

Indeed, far from being all about running faster and jumping higher (what he calls "all that Six Million Dollar Man stuff"), Herr sees the great challenge being how to understand, harness and even repair the brain. "I focus on how to get information out of the peripheral nerves. When we can do that, we can contemplate treating anxiety, schizophrenia, depression – all of those things".

The consequences of such an advance, he believes, could be immense. Not least because, as he points out, half the US population suffers some form of cognitive, emotional or physical disability.

As bionics become more sophisticated, the field of medicine will, Herr believes, have to consider a range of complex ethical issues, not the least of which will be whether to repair an existing limb or replace it with a bionic alternative. He says: "Eventually, we're going to get to a place where the bionic limb exceeds the capability of the biological limb. Today, people with severe problems with their limbs are asking doctors to amputate their limbs to improve their quality of life. If they turn on the TV and see me climbing or someone running very fast, they will ask themselves why they should be in that situation.

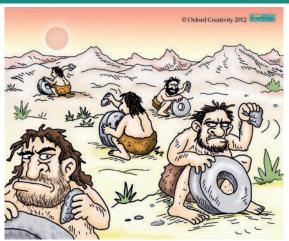
"When a person has a biological limb, but suffers from some pathology, they typically will go through surgery after surgery to retain some sort of capability. Now, however, there is debate in reconstructive surgery circles about the possibility of taking state-of-the-art limb transplantation and whether it should go biological or synthetic. In terms of patient outcomes and quality of life, there is a strong argument that bionic transplantation will make more sense."

Herr is in no doubt that this is where the technology is heading and his ambitions for it are huge. He says: "I envisage a world in which the technology is so advanced and the human/machine interaction so profound that we can rid the world of disability... and that's the goal: an end to disability."

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Match maker

Recruitment consultants have a very close view of the skills shortage.

Paul Fanning talks to one of the UK's leading agencies.

"The perception of

manufacturing tends

to be more negative

engineering and

he effects of the skills shortage are increasingly being felt in all sectors of the engineering industry, but perhaps the most immediate shockwaves are inevitably felt in the recruitment sector.

Keith Lewis, managing director of Matchtech, the UK's leading specialist engineering recruitment agency, is therefore better placed than many to assess the damage being done by a lack of skilled engineers and to predict future outcomes.

One of the biggest problems as he perceives it, is the lack of leadership evident on this issue. "No-one has it by the scruff of the neck," he says. "It's a little bit disparate, which also filters down to the engineering institutions. There's a lot of people trying to tackle the same

problem, but without any joined up thinking. So you've got bodies like Engineering UK, for instance, which do great initiatives like The Big Bang and Tomorrow's Engineers. You've got STEMNet with 26,000 people out there giving a message, so I wonder why these organisations can't work together rather than separately. Also, there must be 30 different Institutes out there and they're all probably giving out a separate message."

To add its voice to the clamour for action on this matter, Matchtech recently launched its annual

Confidence Index. This revealed a strong sense of unease from UK engineers about the government's ability to secure the future of their industry in the UK. The results of the survey show that over three quarters of British engineers lack confidence in the government's action to encourage innovation in the UK, while nearly two thirds of engineers believe the UK would cease to be a world leader in engineering in the future.

While this paints a worrying picture, Lewis points out that the engineering sector itself is in fact thriving. The problem is that the negative or mistaken perceptions of engineering persist regardless of the condition of the industry. "The perception of engineering and manufacturing tends to be more negative than positive," he says. "So you tend to hear a lot about Portsmouth Naval base closing, but hear nothing about JLR expanding or Nissan's new facility."

However, the effects of this shortage are very real and already being felt in a number of quarters, particularly in terms of the passing on of information and knowledge. Says Lewis: "The engineering community is an ageing one. They are having to work longer and it's increasingly falling to the client to have to draw on that knowledge and impart it on to other people coming up through the business. So there's a real

challenge there to get the job done, but at the same time to ensure that the people underneath are learning at the same time."

When it comes to the question of how to improve matters, Lewis is keen not simply to point the finger at Government, saying: "When we talk about what can be done by Government, I'm very conscious of saying 'Government' rather than 'the government', because the skills shortage is hardly a new issue. It's been building up over a long period of time and is independent of party politics."

That said, however, Lewis believes that the current government's increased emphasis on manufacturing and engineering is a positive step, the effects of which

are only just starting to be visible.

"It's too early at the moment," he says. "It's great, of course, but what I would say is that I think this is reflected in the Confidence Index. That shows an 11% increase in policy confidence to 58%. That's the only tangible thing I've seen so far

and that's obviously great. However, I'd like to see that that confidence was reflected across the whole of the engineering community."

Of course, one thing that would greatly improve the situation would be if more women were to join the engineering profession.
Says Lewis: "It's a huge issue, which is surprising in some respects as there are more young girls pursuing maths and physics, but they aren't coming out the other side into engineering."

Of course, the perception of engineering as being male-dominated is one problem in this





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A linear transport that is claimed to unite the benefits of rotary and linear systems, save valuable space and offer huge flexibility is now available in the UK.

The XTS (eXtended Transport System) is a mechatronic linear transport system containing all functions necessary for operation: a modular, fully integrated linear motor with power electronics and position measurement in a single device, a mover as a moved part and a mechanical guide rail.

According to Beckhoff, the most diverse applications can be realised with these few, coordinated components. The desired geometries, lengths and radii are formed by the number and choice of the components. XTS enables individual product transport with a continuous flow of material and, due to the low construction volume, the energy efficiency and the size of a machine can be significantly improved.

In essence, the XTS is a linear motor that travels in a circle. It is modular in nature and offers arbitrary installation position and a length of 10m and more. In fact, though, according to Bradley McEwan, Beckhoff Automation's business development manager: "The only real limits on the system's potential size are voltage drops – ie the availability of power supplies – and bearing size."

As previously mentioned, perhaps the XTS'

greatest benefit is the significantly reduced footprint required by machines that incorporate it. The possibilities are clear in comparison with acceleration and deceleration conveyor belts . These mechanically complex, space-consuming and correspondingly expensive belts are often required to maintain a uniform distance between – for instance – objects in a packaging line before they are transported for sealing. Thanks to XTS with its synchronised movers, no conveyor belts are necessary, resulting in a significant reduction in both costs and machine footprint.

new degrees of freedom for mechanical engineering. Paul Fanning reports.

XTS also enables the maximum possible utilisation of the machine footprint, as the circular movement allows travel in both directions as well as curves. Equally, complex cabling and drag chains are no longer required, while the position measurement system is already integrated.

Perhaps the most eye-catching features of the XTS, however, are the movers, which can accelerate, brake, position and synchronise. They can also take up absolute positions relative to one another, group themselves and accumulate, create clamping forces in motion, travel along curves as fast as along straights and even recover energy though regenerative braking.

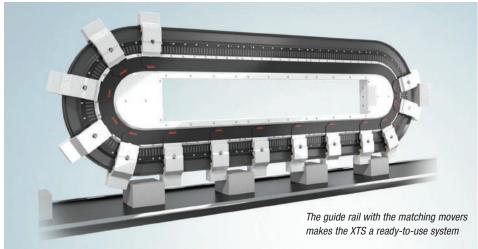
The movers themselves are made of a light and solid aluminium alloy. They contain magnetic plates that , together with the coils of the motor module, generate a controlled driving force. The attractive forces of the magnetic plates are largely balanced by the opposed arrangement, so that the rollers and the rail do not have to absorb the comparatively high attractive forces of the magnets.

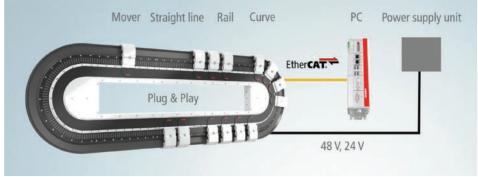
Thanks to their arrangement the rollers allow backlash-free travel on the straights and in the



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curves. The coating of the rollers causes very little running noise and is particularly low-wear without lubrication of the guide rail.

The centre of the encoder flag supplies a position signal to the motor module. Movers can be distinguished from each other by the encoder flags, which are made from a sturdy, lightweight glass-fibre reinforced material.

The motor module, the power electronics and the displacement measurement are built into the profile. The power electronics are optimised for the requirement and reduce assembly expenditure. There is an upper mechanical interface to the guide rail and a lower one to the support structure. Straight segments and curves can be combined however suits the application. Because the motor module is without edges and openings, it also allows easy cleaning.

The motor contains the electromagnetic coils and all other active functions necessary for the operation of the system. Only a power supply and an EtherCAT connection are required. A control cabinet is no longer required. The motor module contains no moving parts and is

therefore not subject to any wear. The coil arrangement and the mechanical configuration are ready for use.

Integration of displacement measurement eliminates the need for additional installation and the calibration, while tolerances are compensated automatically.

XTS uses a double air gap linear motor, with magnets positioned above a coil package on opposite sides. The high attraction forces of the magnets cancel each other out, which means that only low resultant forces act on the mechanical bearings.

The guide rail with the matching movers makes the XTS system a ready-to-use solution. However, the motor modules can also be used together with the magnetic plate sets as a custom solution without the XTS guide rail. The movers can be removed or inserted without tools through a lock by releasing two screws and removing part of the rail.

The rail system can be extended with straight and curved sections as required. The desired geometries, lengths and radii are formed by the

number and choice of the components. In combination with the contact surface of the mover rollers, the system results in good running characteristics and low wear.

The guide rail system is optimised for instant installation on the motor module and minimum manufacturing tolerance and pre-stressed rollers ensure zero backlash. The guide rails have no joints and are available in lengths of up to 6 m. Fittings ensure high-precision mounting.

Movers and guide rail are optimally matched to each other. The geometry of the rail and the hard anodised aluminium of the surface allow good running characteristics and low wear. Lubrication of the system is therefore not necessary.

In terms of applications, XTS can obviously be used in a variety of sectors where there is a need for high-speed handling. However, according to Bradley McEwan, market response has been positive. He says: "The UK is an early adopter and we have already sold a couple of systems", although the company is not yet able to disclose who these customers are.

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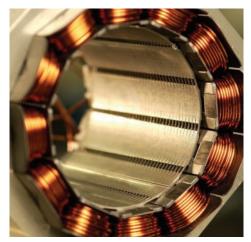
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High-speed machines drive technology forward

There is a demand for high-speed advanced electrical machines and drives for wideranging applications in all market sectors. Eureka reports on this technology.

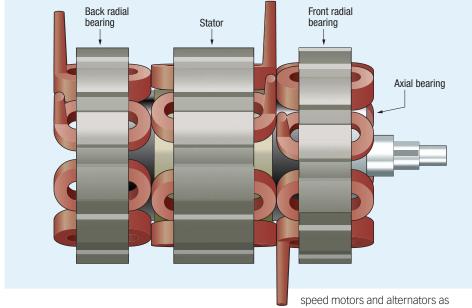
There is currently significant attention being paid to the development of high-speed machine technology such as motors and generators. In particular, permanent magnet machines are gaining traction due to their outstanding efficiency, high power density, small size, low weight, simple mechanical construction, easy maintenance and good reliability.

The motivation for their development varies considerably. However, common objectives are to improve efficiency, conserve energy, reduce environmental pollution, increase power density, enhance functionality and improve reliability and maintainability and is also being driven by legislation, consumer expectations regarding performance and more fierce competition in the market place.

Many of the applications for these machines pose particularly severe challenges in terms of the rotational speed and/or space envelope constraints (eg the thermal operating environment) for example, while others are particularly challenging in terms of being highly cost-sensitive or safety critical.

In the past, many industrial applications have used existing technology to achieve high rotational shaft speeds. Direct-drive high-speed machines or a slow-speed electric motor coupled with a speed increasing gearbox have typically generated the necessary shaft speeds. But advances in high-speed motor technology, along with improvements in the cost and performance of power electronic drives, materials, non-conventional bearings and more efficient cooling methods, permit an alternative approach.

This uses high-speed machines that can directly drive, or be driven by a high-speed



system such as turbine, compressor or other turbomachinery. This results in significant performance benefits, such as reduction in motor generator size, as well as reduced cost and simplified integration. Integration of these small, highly efficient machines into the coupled equipment further reduces cost and complexity

Recently, researchers have focused on the design of high-speed, super high-speed, or even ultra-high-speed machines for applications such as turbochargers/superchargers, compressors, spindles, blowers, pumps, flywheel energy storage systems and machine tools that require higher speed drives. Such high-speed machinery includes gas compressors, pumps, centrifuges, distributed generation units (microturbines), spindles and flywheel energy storage, and high-

examples of electric machines.

The increasing interest in these types

of machines is partially due to the very small size and weight achievable in comparison to machines using conventional design strategies.

The higher the motor speed, the smaller the electric machine volume for the same power output. The volume of the machine is proportional to the output power and inversely proportional to phase current density, airgap flux density and the angular velocity.

Although current density can be increased considerably by using super conducting materials, it is still very expensive and not suitable for low-power machines. The large number of additional components required to provide cryogenic temperature for super

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conducting will reduce the power density greatly for low-power machines. Therefore, increasing rotor speed is desirable to increase power density of the machine.

The advent of cost effective frequency converters has allowed the speed range of larger electric machines of 100 to 1,000 kW to be increased to 4,000-6,000 rpm. The prospect of a permanent magnet motor of 20MW operating at higher speed offers the possibility of low mass, very compact geared or direct-drive, which have been used at these higher speeds for decades, i.e. in combination with both steam and gas turbines.

Operating speeds cover a broad range, from 10 to 200k rpm. Increasing speed is one of the most powerful elements for improving if the application can stand it. The design of high speed machines is known to be very challenging because materials are operated closer to their mechanical limits.

The high speed capability of machine is constrained by several parameters, such as rotor mechanical, thermal, and electromagnetic limits. Additionally, one can enlist the limits of the power electronic converters, especially the switching frequency.

From an electromagnetic point of view, higher speeds mean higher induced voltage, with extra stress on the insulation. The skin effect due to high frequencies increases the AC resistance.

Increasing speed also presents mechanical integration complications, however. Among these complications are rotor-dynamic behaviours related to the phenomenon of critical speed. Part of the structure comes to close to the elasticity/plasticity limit, which makes material choice difficult, since most strong materials are non-magnetic and reverse. The centrifugal force wants to radially push out any component in the rotor. This may cause difficulties for rotors with windings or permanent magnets, close to the air gap. It is possible to use a thin non-magnetic bandage (e.g. fibre-glass) or high-strength metal sleeve or a proprietary advanced graphite-composite sleeve can be used that offer unique advantages to machine performance

The magnitude of the air gap also plays an important role. The bearing needs to be able to sustain, in a stable way, the envisaged speed. Transition to non-touching air bearings/ foil or magnetic bearings has created excellent



opportunities for increasing speed and improving reliability.

Speeds within the range of 20-50k rpm are well within conventional bearing capabilities. However, for improved reliability, foil bearings are highly desirable, although the size of the foil bearings is inversely proportional to speed.

Also, a higher number of machine poles can be selected for improving performance. The fundamental of the machine current is a multiple of mechanical frequency. However, machine current should be low enough for easy integration with the power electronics.

Fundamental electrical frequencies above 1.5 kHz should be avoided to prevent distorted stator currents, which result in increased machine losses and electromagnetic interference (EMI). In this speed range, 4-, 6- and 8-pole machines may be selected.

For speeds below 20k rpm, foil bearings are not feasible due to increased size. Rotor-dynamic behaviour usually does not create problems since the first critical speed is far above the operating speed range. An increased number of poles can be used for reduced machine sizes.

The size of the magnetic bearings is not very sensitive to the operating speed ranges. Implementations at high speeds are more challenging since higher frequency bandwidth is required. This is due to the fact that the critical speeds are within the operating speed range.

SDT has developed a high-speed permanent magnet motor that can deliver between 2 kW-5kW and integrated control system, which is designed to run at up to 50,000 rpm and have

integrated controllers.

To further increase the capabilities of proprietary high speed motor systems, As a specialist in high-speed electric drives, UK-based SDT uses a technique called phase advance controlthat allows the delivery of high output torque at high speeds. This method allows phase current to build up in a motor winding before back EMF reaches any significant level.

In this development, the following materials have been used have properties that greatly influence

motor performance: the permanent magnet, core ferromagnetic materials, magnet wires, winding insulation. However, since SmCo magnets have a much higher temperature stability it was decided to use them for the magnet poles. The two important characteristics of the ferromagnetic materials that have influence on the motor performance are the maximum saturation flux density and the specific core loss. The high saturation cobalt iron alloys have high maximum saturation flux density and a relatively low specific core loss.

This high speed machine solution is highly scalable and provides a solution for where consideration is being given to a variable speed drive to better match the drive to varying load requirements to reduce energy consumption. Suitable applications are currently being found in automotive, commercial vehicles, spindle, aerospace, industrial pumping and many other industries where compact, high performance machines and flexible transmission technology are demanded.

Given the challenging requirements of highspeed, high power motors in a small package, reliability is best ensured using a comprehensive engineering approach such as thermal, structural, dynamic as well drive electronics, and high performance bearings.

An electric motor is a complex piece of equipment, covering many engineering disciplines. Careful consideration must be given to all aspects of motor design when evaluating the impact of high rotational speeds and increased frequencies. Ultimately, the final design will be a tradeoff between multiple aspects of machine design, including rotor tip speed, rotordynamics, and cooling.

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A new 3D printer capable of making parts using carbon fibre could be a real breakthrough for the material and the production technology. Paul Fanning reports.

ranny years now, the words 'carbon fibre' have virtually been a shorthand for cutting edge material usage, quality, strength and light weight. These properties have meant that carbon fibre composite parts have been extremely popular in aerospace, high-end automotive, motorsport and other prestigious applications.

However, the nature of these applications also highlights the major issue with carbon fibre – namely its expense. The reason it is largely used in high-end applications is that only they can afford it.

Someone who had first-hand experience of the difficulties posed by carbon fibre was Greg Mark, who co-owns Aeromotions, a company that builds computer-controlled racecar wings. To make those wings both strong and lightweight, it uses carbon fibre. Here, though, the problem is that making custom parts out of carbon fibre is extremely challenging, costly and time-consuming.

With these problems foremost in his mind, Mark sought alternative methods in the form of 3D printing. To his frustration, however, nothing on the market could print the material, and no available materials could print pieces strong enough for his purposes. This led him to devise his own solution: the MarkForged Mark One, the world's first carbon fibre 3D printer.



Carbon fibre joins 3D print revolution

Says Mark: "The expense in composites has traditionally been in both the material and the hand layout process. You have to lay out all the fibre in the moulds, you infuse the resin; you trim it, you cut it, you glue it together. It's a lot of labour. What we did was we took that idea of laying up composites and then we took the mechanics of a 3D printer and we put it together. So essentially you push the button and it does all the labour for you."

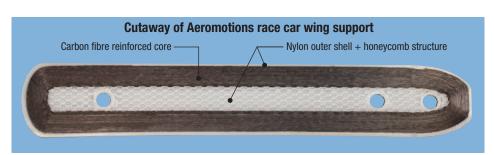
This, of course, sounds deceptively simple,

but – needless to say – it is not. The machine has two print heads. One head is capable of printing composite filaments (CFF) in carbon fibre and the other, traditional thermoplastic filaments (FFF). Parts may be printed either by a single head or a combination of the two.

"We had to do two things," says Greg Mark.
"We had to make this new material and then we had to make the machine that printed it. Instead of just printing plastic, we reinforce the plastic with carbon fibre and make it 10 times stronger than plastic has ever been before."

What this means is that the main structure of an object can printed in a material like PLA or nylon, and then carbon fibre added as a thick layer just below the surface. The company reports that the carbon fibre filament is twice as stiff and five times stronger than ABS plastic, which is a bit less rigid than PLA plastic.

What makes the Mark One different from other 3D printers is that it uses a new 3D printing



www.eurekamagazine.co.uk March 2014 39



process referred to as CFF (Composite Filament Fabrication) in combination with traditional FFF Parts made with CFF are reinforced by continuous strands of fibres embedded in a thermoplastic matrix. Fibre-reinforced composite parts have many excellent structural qualities. The parts printed on the Mark One are up to 20 times stiffer and five times stronger than similar parts 3D printed using ABS plastic. Their strength depends on the type, orientation, and volume fraction of the reinforcing fibres.

As well as carbon fibre, the Mark One can 3D print a range of other materials to help professionals design and iterate quickly. It is possible to make tough parts with Nylon Filament or load low-cost PLA filament for quick form and fit prints. And if you need the best costto-strength solution, it is possible to a print using MarkForged's exclusive Fibreglass Filament, which uses the same patented Continuous Filament Fabrication.

The Mark One does not print with a weave. instead depositing layers of unidirectional composite in a user-defined orientation that can be specified by layer. In general, unidirectional composites have a higher strength-to-weight ratio in the preferred fiber orientation than composites made with woven fabrics.

Quite how significant this development could prove to be is emphasised by Jon Hirschtick, founder of SolidWorks, who describes it thus:

"This is a significant advancement in materials science. For the first time you can 3D print a part that is as strong or stronger than metal."

Says Mark: "People have been trying to do this for at least 18 years... We knew we had something special the first time we took a part off the print bed and went to bend it and, instead of feeling like plastic and giving, it had the resistance and stiffness of carbon fibre."

The machine also features It features an anodised aluminum unibody and a translucent printing bed. Kinematic coupling makes it simple to level the bed (indeed, the bed clicks into the

This new 3D printer puts custom carbon parts within

the reach of a range of industries

same place every time within 10 microns). The printer itself is compact and elegant looking, measuring 574mm x 361mm x 323mm, making it a genuinely desktop unit.

Ultimately, of course, the really exciting thing about this technology is that it puts custom carbon parts within reach of all sorts of other industries and allows intricate shapes to be formed that would be very difficult to create using traditional carbon fibre manufacturing techniques. This, according to the company, has already meant a great deal of interest from a number of new markets.

One market that has shown particular interest is the medical prosthetics sector, where the ability to produce parts easily and less expensively in carbon fibre could prove revolutionary. Indeed, speaking at SolidWorks World recently, Hugh Herr of Biom (see cover story) specifically pointed to the Mark One, saying: "To be able to 3D print composites is very exciting. Biological tissues are essentially composites and composites have many extraordinary properties. They're very lightweight and strong, so to be able to print such 3D structures is very exciting."

The printer is in a prototype stage at the moment, but will sell for about \$5000 when it hits retail. Pre-orders for the printer have started, with shipping in the second half of 2014.

https://markforged.com



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Il the components subject to wear are contained in a cartridge unit that can be easily removed for inspection and/or replacement without disconnecting the pump from the circuit, drastically reducing expensive machine down time.

The cartridge contains a rotor, vanes and inserts, a cam ring and two covers. During operation the rotor is driven by a splined shaft coupled to the drive unit. As the rotation speed increases, centrifugal forces, in combination with the pressure generated behind the vanes, push the vanes outwards, where they follow the profile of the cam of the ring with a sufficient contact pressure to ensure adequate hydraulic sealing. The two opposed pumping chambers formed by the

elliptical profile of the cam cancel out radial loads on the shaft bearings, thereby giving them extremely long lifetimes.

The versatility of this series of pumps enables them to meet the requirements of the most varied industrial applications. In fact, as well as their proven high reliability and excellent volumetric efficiency in all working conditions, they operate with particularly low noise levels. This is made possible by the special profile

of the cam ring and the use of a 12 vane rotor that reduces the amplitude of the supply pressure pulses, thereby reducing induced vibrations. These vane pumps are extremely compact and are supplied with ISO norm mechanical couplings and SAE norm hydraulic fittings. This makes them very easy to install and guarantees their interchangeability with other similar pumps (eg. Vickers, Caterpillar, Denison).

www.jbj.co.uk/vanepumps.html













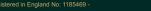
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3D puzzle designed using AM technology



In the mid 1970s, Rubik's Cube became one of the world's most popular toys and by January 2009, more than 350 million had been sold. Now, a successor has arrived that could only have been created using additive manufacturing (AM), or 3D printing technology.

The new Marusenko Sphere is both a 3D logic puzzle and an educational toy. It is available in ten colour schemes and five levels of difficulty, depending on the configuration and colour combination of its 32 exterior pieces, which are supported by 22 internal elements. The puzzle is solved using nine different types of movements – two meridional and perpendicular to each other, one equatorial and six polar.

Rapid prototyping from plastic powder in an EOS FORMIGA P 100 additive manufacturing machine played an important role in making the toy a reality. When the design phase of the sphere in CAD was complete, electronic simulation had to give way to testing of a physical model.

AM was the logical approach to producing prototypes, due to the toy's complexity, the need to make mid-process adjustments to the shape of the 54 pieces, and the need to avoid adhesive, springs, screws or shafts to promote child safety.

The many stages of adjustments to geometry and tolerance were made in an EOS FORMIGA P 100, a system that produces plastic parts from polyamide powder, layer by layer, directly from CAD data within a few hours. Multiple trial and error tests were performed to refine the toy's mechanics until the final level of perfection was achieved.

The flexibility and speed of the AM machine were essential for producing the successive prototype iterations cost effectively and quickly. The process was key to ensuring the success of the final, sales-ready product.

www.eos.info

3D printing to grow apace in coming years

The IT, software and telecom industry research specialist Business Advantage Group has announced its 2014 Worldwide CAD Trends Survey, including more details specific to 3D Printing.

"3D Printing is currently used by 14% of the CAD users surveyed and strong future growth is anticipated. By the end of this year 21% expect to be using 3D Printers and in the next five years, 32% expect to be using 3D Printing... current usage by region shows higher usage in the Americas (26%) than in EMEA (12%) and Asia Pacific (11%) as well as higher usage in large companies (28%) than in medium (16%) or in small (6%), said Chris Turner, CEO/Managing Director of Business Advantage.

Based on those CAD users already using or planning to use 3D printing, the main benefits are seen as design improvements (63%), savings in design time (54%) and cost (24%), as well as faster response times to market (38%).

Objet500 excels in action

Engineers at Trek Bicycle in Waterloo, Wisconsin are using the Objet500 Connex3 Color Multimaterial 3D Printer for assessment and testing of accessories like bike chain stay guards and handlebar grips prior to actual production. "The Objet500 Connex3 Color Multi-material 3D Printer changed the way we manufacture at Trek, augmenting our traditional, time-consuming CNC processes with fast, iterative and realistic prototyping and functional testing," says Mike Zeigle, manager of Trek's prototype development group.

"Now we produce bicycle parts that look and feel like production parts. We are particularly excited about 3D printing our models directly in color. This gives our designers the ability to graphically display color contact pressure map data on rider contact parts like seats and grips. We are also working on doing the same with FEA & CFD stress data on structural bike components," adds Zeigle.

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Stratasys wins dental award

Stratasys' Objet Eden260V 3D Printer has won the 2014 Product Award for Top Innovative Equipment from The Dental Advisor magazine. The Objet Eden260V 3D Printer was the only rapid prototyping platform honoured in the annual Product Award list for the second year in a row. The magazine sited the system's outstanding surface detail, easy management and maintenance, high resolution in all axes, and high speed in high quality 3D printing modes as reasons for its selection.

"We are honoured to be recognised by The Dental Advisor for the second year in a row. The high degree of interest reflects 3D printing's growing importance in digitizing dentistry and the significant value that the Objet Eden260V 3D Printer has in redefining manufacturing in the dental lab industry," said Avi Cohen, Director of Global Dental, Stratasys.

"Through the use of proven Objet 3D Printers for additive manufacturing and dental models with our advanced, medically approved materials, our customers are able to provide highly accurate and excellent-quality dental models and parts efficiently and cost-effectively. Moreover, dental labs are increasingly using the Objet-line of 3D Printers to offer a greater variety of dental solutions to their dentist clients, including in-house fabrication of fine detail models with outstanding surface finish."

We believe that 3D printing is one of the key factors driving the new digital era in dentistry. By combining oral scanning, CADCAM design and 3D printing, dental labs can accurately and rapidly produce dental stone models, and a range of orthodontic appliances for dental offices.



This most recent recognition joins a growing list of awards earned by the Stratasys Objetline of Dental 3D Printers, including the Dental Advisor 2013 Innovative Equipment Award and the Dental Labs Products 2011 Readers' Choice Award. www.stratasys.com



The steering wheel design that Cambridge Design Partnership delivered last year to the Bloodhound Project is on display at the London Science Museum's 3D printing exhibition.

The exhibition explores how 3D printing will shape the future, featuring stories such as creating lighter, more efficient parts for aeroplanes and 3D printed replacement body parts.

The Bloodhound Project is one of the UK's pioneering engineering projects, and the wheel was selected to feature in this innovative design exhibition, which showcases over six hundred printed objects, to highlight the versatility and range of 3D printing.

Cambridge Design Partnership took initial concepts of the supersonic car's steering wheel, and developed them into a design that will meet the demanding requirements expected during the land speed record attempt. The final wheel will be printed from titanium using the very latest in 3D printing technology.

Commenting on the use of 3D printing, Dan Johns, Engineering lead on the steering wheel at Bloodhound said, "We wanted to break away from a conventional functional driven design philosophy and use a more creative approach to the design solution. Deciding early on to use Additive manufacturing (3D Printing) as the manufacturing process allowed us creative freedom to explore nature's structures and influence the shape."

The exhibition also includes a number of previous prototype designs for the wheel, which highlights the importance of innovation throughout every stage of the development process, and the versatility of rapid prototyping. www.cambridge-design.co.uk





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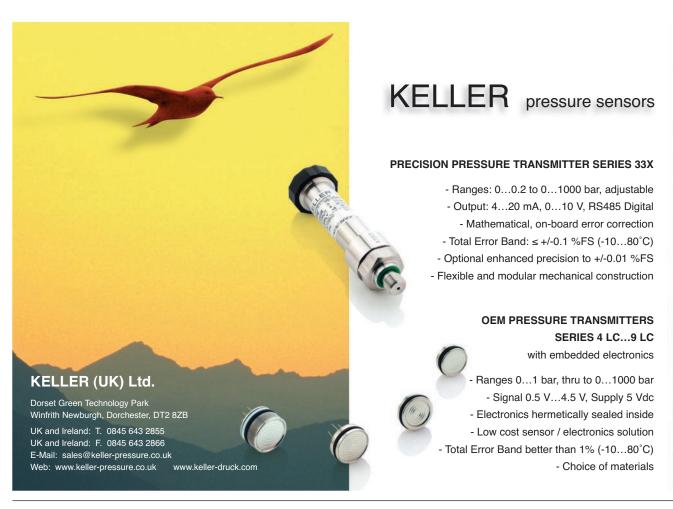




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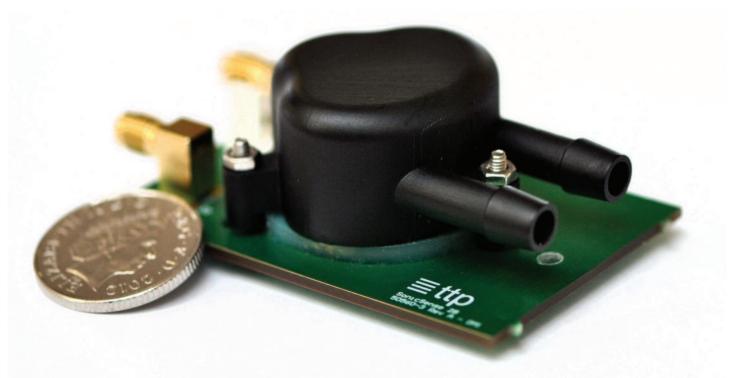
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Gas sensing breaks sound barrier



A new, low-cost sensor technology is able to deliver accurate gas sensing at a fraction of the cost of existing methods. Paul Fanning reports.

TTP, a leading UK-based technology and product development company, has come up with an innovative approach to gas sensing that radically cuts cost, size and power consumption. The new ultrasonic sensor uses patent-pending TTP technology to precisely measure the speed of sound in a gas to determine its composition and can also be connected wirelessly to the Internet for remote monitoring and data collection.

Drawing on TTP's expertise in non-linear acoustics and piezoelectric technology, the new SonicSense devices will cost between £3 and £6 each in volume production. TTP is investigating a wide range of industrial and medical applications, from gas safety and process control to respiratory monitoring and anaesthesia. Once the speed of sound through the gas is measured, thermal compensation is applied before the composition of a binary gas mixture is calculated. Additional bulk gas properties such as density can also be

determined using the same sensor architecture to enable more complex gas mixtures to be evaluated.

SonicSense can be used to detect dangerous levels of methane in natural gas or biogas plants and can also measure the calorific value of production gasses for quality and pricing control as well improving furnace or boiler efficiency. However, potential applications are wide ranging and diverse. For example, as the development of hydrogen fuel cell cars and their supporting infrastructure reaches a national scale, there is a growing requirement for filling station operators to monitor levels of hydrogen gas; while the new sensor technology can also detect levels of the extremely potent greenhouse gas Sulphur Hexafluoride used in high voltage electronics.

TTP has developed prototype sensors for their existing clients with a sensor diameter of only 24 mm and a depth of 18 mm – but it is expected that this dimension can be reduced to less than 5 mm. With a simple, robust design

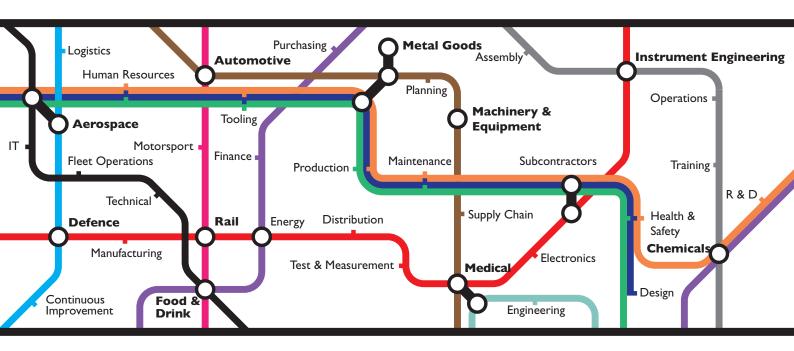
and low power consumption of around 10mW – compared to over 1 W for some gas sensors – the TTP device is ideally suited to long-lifetime, battery powered applications with no in-field replacement or calibration required. And with growing interest in M2M communications and connected devices, TTP's expertise in wireless communications supports the integration of SonicSence devices into an Internet of Things (IoT) ecosystem.

"Many industrial gases are expensive or difficult to measure directly," said Andrew Baker-Campbell, one of the inventors of the SonicSense technology at TTP. "From precisely controlling process gasses for semiconductor fabrication to protecting workers from asphyxiation in the brewing industry, we are keen to work with development partners who see an opportunity to harness and commercialise this exciting new sensing technology."

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Rig tests subsea systems

A new test rig for onshore/offshore use allows for the streamlined cleansing and pressure testing in-situ. Paul Fanning reports.

As the exploration depths involved in offshore oil production continue to get deeper, the development of more complex subsea structures, connected by umbilical systems, becomes a necessary part of the production infrastructure. Due to increased pressure on efficiency and reliability it is necessary for umbilical systems to be tested and cleaned at regular intervals and after production.

As the name suggests, the umbilical system is the lifeline for the subsea structures used in offshore oil and gas production. It provides the link from the host facility through which control is exercised, power is transmitted and utilities such as injection chemicals are supplied to the subsea wells. With the continuing trends in subsea to shore installations and operations in deeper and deeper locations, umbilical systems have to cope with increased stresses.

The umbilical is a long, flexible construction – its length can be anything from a few miles to more than 180 miles – which consists of tubes, cables, armouring, fillers and wrapping contained within a protective sheath. The multiple functions it performs and the demanding environment in which it is installed and operates, mean that the umbilical is necessarily a very hi-tech product which must perform reliably while in operation.

Due to the critical nature of the systems and valves, which are controlled by the hydraulic umbilicals throughout the subsea networks, it is essential that the hydraulic fluid be cleaned to the required specifications. The lines and connections must also be regularly checked for leakage to ensure that they operate correctly and with the necessary reliability and efficiency. In order to carry out the cleansing and checking procedures a test rig is required which is capable of flushing out the entire umbilical length and submitting it to a pressure test.

during t return filte

Due to the size of the pump needed for the operation, these tests must traditionally be carried out onshore, which necessitates complex logistics and becomes extremely inefficient. To improve the efficiency, however, a leading manufacturer of bespoke umbilical products, wanted to develop a test rig which would be suitable for off-shore use.

The list of design criteria was long and exhaustive. The new test rig had to be enclosed in a custom steel framework which would allow it to be lifted by a crane and also be able to fit inside a standard cargo container as well as act as protection from occasional knocks.

With the dimensions of the rig established, the heart of the system would be the high pressure pump, which would have to be capable of producing pressures up to 1,035 bar with flows between 11-56 litres/min). Achieving these figures would reduce the overall time required to fill, flush and pressure test the umbilical system, which in turn would reduce the cost of the installation and sale of umbilicals. With the test rig being designed for off-shore use it was essential that the pump offered the highest degrees of reliability.

In addition to these standard requirements, and to make it suitable for use on the pumping platform, the entire rig needed to be intrinsically safe; meeting Class I, Div II classification for both offshore and onshore use. The test rig also required the ability to filter the fluids being used in the test procedure to ensure the umbilical pipes were not contaminated. The filtration package would require three micron filters to be installed on both the suction and the pressure sides of the main oil reservoir to prevent any contamination

during the testing procedures. Additionally, two return filters were added to ensure minimal contaminants returned to the reservoir.

The challenge of supplying a pump capable of meeting these demands while also offering complete reliability was offered to RMI Pressure Systems, global leaders in high-pressure pumping solutions. RMI designed the steel frame of the test rig around its Trimax S250 high-pressure pump. The pump is controlled by a Toshiba variable frequency drive (VFD) and Omron PLC and is suitable for both the flushing operation and the high pressure testing. Using a single pump for both procedures reduces the overall operation time which in turn reduces costs.

The Trimax range of crankshaft-driven, reciprocating pumps provides high efficiency pumping at pressures up to 1050 bar and flows up to 610 litres/min. The S200 and S250 are both three piston, crankshaft driven, positive displacement pumps. The design of the pumping system enables the units to operate in hazardous conditions without modification. However to meet the intrinsically safe specification for the entire test rig, several modifications were required, including the installation of a nitrogen purge system for the VFD and various explosion-proof fittings.

www.rmipsl.com

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Playing it cool



Current refrigeration technology has been with us for a while, but can it be improved upon?

The fridge is the most ubiquitous of household appliances and could be argued to be one of the most important. The ability to preserve fresh food for far longer than would naturally be feasible has made a vast difference to human nutrition, health and welfare, increasing the quality and length of all our lives.

All these benefits have come at a price, however. Despite improvements in efficiency over the years, refrigerators remain one of the biggest users of electricity in the home. This is because they rely on chemical refrigerant and a compressor to transfer heat from the inside to the outside of the fridge.

Essentially, the technology behind refrigeration has changed little since the early 19th century. A liquid is rapidly vaporised through compression – the quickly expanding vapour requires kinetic energy and draws the energy needed from the immediate area - which loses energy and becomes cooler. Cooling caused by the rapid expansion of gases remains the primary means of refrigeration today. All that has essentially changed are the chemicals that have been used.

The problem, though, is that this is a highly energy-hungry process. Plus, of course, the



refrigerants themselves have caused more than their fair share of problems over the years, with chlorofluorocarbons (CFCs) having been responsible for a disproportionate amount of environmental damage until their use was finally outlawed in 1996.

The challenge

The challenge this month, then, is to come up with a means of refrigeration that doesn't have the drawbacks associated with the traditional method

Of course, there is always the option of

returning to the old method of refrigeration, which involved simply putting things literally 'on ice'. However, such a method begs the question of where the ice would come from in the first place, not to mention the fact that it is an inexact means of cooling.

As ever, we have a solution in mind already. This employs long-understood physics, but new and highly innovative materials. Indeed, it is claimed that the technology is much more environmentally friendly than current refrigerators, being as much as 20-30% more efficient.

However, that isn't to say that Eureka's readers cannot come up with something better. The solution we have in mind will appear in next month's issue, but we look forward to finding out what you have to say.

The answer to last month's Coffee Time Challenge of how to use electronic devices while riding a motorcycle can be found in our Technology Briefs section on page 15.

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AC Variable Speed Drives

Vacon drives don't mind the snow

Even when they're operating outdoors in extreme weather conditions ac variable speed drives in the latest Vacon 100 X range need no additional protection of any kind, making them a cost-effective and convenient choice for use in demanding environments where ordinary drives would need to be mounted within a protective enclosure.



With a power range up to 37 kW, which is unmatched by competitive products, VACON 100 X drives feature a rugged die-cast metal enclosure with an IP66 ingress protection rating and have an exceptionally wide operating temperature range of -40 °C to +60 °C, allowing them to perform reliably and consistently in even the toughest of operating conditions.

The drives can be mounted in any orientation and are also resistant to vibration up 3g. They can, therefore, optionally be mounted directly on the motor they are controlling and, in appropriate applications, this can result in valuable space savings as well as reducing the amount of cabling required.

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Coatings

WS2 Stops galling of SS and **Titanium**

Stainless Steels and Titanium are both prone to galling and seizing. WS2 is a very low friction dry lubricant surface treatment, developed by NASA for use in deep space. It has been shown to provide a very cost effective solution, preventing both problems on threads and other sliding surfaces.

WS2 works well from -273° to 450° C and down to 10-14 Torr. WS2 has been applied to bearings and gears to extend life.

Design Out maintenance problems with WS2!



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Electronic Torque Wrench

Norbar Launches New Electronic Torque Wrench

Norbar Torque Tools has launched its first electronic torque wrench, the Nortronic®, designed to offer users unprecedented torque and angle control

To meet the demands of industry for quality control and production traceability, Norbar has designed an electronic torque wrench that is capable of measuring, displaying, storing and transmitting torque and angle target results and receiving configuration settings from TDS (Torque Data System) computer software via a USB or wireless interface.

The new electronic torque wrench will provide operators with a complete data management and archiving system. Two way data management capabilities also mean that multiple targets can be sequenced and linked as well as tool settings configured at PC.

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Flowmeters

Litre Meter ships big order down under

UK flowmeter specialist Litre Meter has shipped 12 LF05 VFF positive displacement flowmeters to Kempe Australia for use in chemical injection applications offshore New Zealand. The rotary piston flow meters are to be used to measure the flow of a number of chemicals including corrosion inhibitor, demulsifier and scale inhibitor. Five skids, each with its dedicated flowmeters, are being constructed for the Maari Growth Project in the Taranaki Basin operated by OMV New 7ealand



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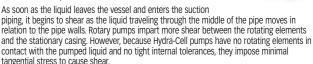
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Pumps

Hydra-Cell Pumps Shear Sensitive Liquids

Pumping shear sensitive materials can be problematical. Shear helps non-Newtonian fluids flow but too much shear can cause temporary or even irrevocable damage. Hydra-Cell diaphragm pumps from Wanner International are claimed to impose only low levels of tangential stress on the pumped fluid making them ideal for pumping a wide range of shear sensitive materials such as polymers, paints, coatings, dyes, inks, latex solutions and technical suspensions.



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Rotary Atomiser

Fine Droplets without High Pressure

The small electric rotary atomiser produced by Newland Design is an efficient way of creating small, consistently-sized droplets by means of highspeed rotation alone, without need of compressed air or any high pressure.

The Newland Atomiser rotates a small porous plastic cylinder at speeds up to 35 000 rpm and emits droplets of less than 40 micrometres in diameter

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SKF Energy Efficient (E2) bearings

Every once in a while, a product innovation comes along that holds the potential for huge global benefits. You already know about energy efficient light bulbs; now discover the possibilities of SKF Energy Efficient bearings.

These ultra-low friction bearings consume a minimum of 30% less energy than the already efficient standard SKF bearings. Compared to other bearing brands the energy reduction can be even more dramatic.

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For further information: www.skf.co.uk/E2



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